# OBSERVATIONS *made on the* DISAPPEARANCE *and* REAPPEARANCE *of* SATURN's RING *in the Year* 1789, *with ſome Remarks on his diurnal Rotation. By the Rev.* H. USSHER, *D. D. M. R. I. A. and F. R. S.*

Read December 5, 1789.

THIS year has been remarkably unfavourable in this country to aſtronomical obſervations in general, but more particularly ſo to thoſe propoſed to be made on the diſappearances and reappearances of Saturn's ring.

THE firſt diſappearance of the ring in the month of May could not from the ſtate of the weather be obſerved here at all.

AUGUST 21ſt. I obſerved Saturn with the greateſt power of the tranſit inſtrument; the ring itſelf was inviſible, but its ſhadow was viſible upon the body, though very faint.

AUGUST 26. Obſerved him with the ſame power, the ring ſtill inviſible.

AUGUST 27. Obſerved him with a forty-inch double object-glaſs, before he was near the meridian; ring ſtill inviſible, at leaſt with that power, viz. 61 *, which power I aſcertained accurately: rain came on before he paſſed the meridian, and the weather continued rainy and cloudy till the 30th.

AUGUST 30. The ring was viſible, particularly on the eaſt ſide, with the forty-inch achromatic mentioned above: the ſame alſo with the greateſt power of the tranſit inſtrument. By comparing the gradual increaſe (as far as I can truſt to my recollection) I imagine that the ring became viſible ſome time in the night of the 28th; I mean to one uſing the ſame inſtruments that I did.

OCTOBER 1. The ring was juſt viſible on the eaſtern ſide only with the double achromatic, and likewiſe with the tranſit inſtrument. Storm came on and continued to the 3d, on which night I got an obſervation, but the ring was not viſible with the tranſit inſtrument; there was a heavy gale of wind.

MR.

* It is much to be regretted that the generality of obſervers do not mention particularly that they have aſcertained the power of their teleſcopes by proper experiments, particularly in obſervations of this ſort. I meaſured mine by two different methods, viz. by the breadth of the emergent pencil, and alſo by the uſual method of a diſtant circle and near parallel lines, the latter method gave 58, the other 61; this I believe beſt.

Mr. Newenham of Cork informed me by letter that he ſaw it on the eaſtern ſide to the 5th, when at 10 H. 30′ he loſt ſight of it. This obſervation he made with a reflecting teleſcope of ſeven feet focus, and power 300.

The power I uſed was ſuperior to this; but the tranſit inſtrument being fixed, is badly ſuited to this kind of obſervation, as the planet paſſes the field with great rapidity, and with this inſtrument one cannot purſue it; which is a circumſtance eſſentially neceſſary to diſtinct viſion, as I formerly mentioned to this Academy in a paper publiſhed in the firſt volume of our Tranſactions.

The obſervations which I have made are hitherto ſo badly circumſtanced, that any deduction from them with reſpect to the tables, &c. would be trifling, until the next reappearance, which may either invalidate or fortify ſuch as have been mentioned.

It is, however, worthy of remark at preſent, that Saturn now diveſted of his ring appears exceedingly oblate; much more ſo than I could have ever ſuppoſed from common obſervation whilſt his ring was viſible: and as his rotation has not, that I know of, been yet determined by any ſpots viſible upon his ſurface, it occurred to me that if his equatorial and polar diameters were accurately meaſured, I could infer his time of rotation by means of the 19th Propoſition of Book III. of Newton's Principles, by a deduction from the formula which he there employed, to find the

the proportion of the polar and equatorial dimeters of Jupiter, by compariſon of the denſity and rotation of the earth with thoſe of Jupiter.

Let $T^2$= the ſquare of the time of the ſidereal rotation of the earth; and $t^2$= the ſquare of that of Saturn, the root of which is ſought: let $\Delta$= the earth's denſity, and $\delta$ that of Saturn; D= Saturn's greater diameter, and $d$ his leſſer one. Then from Sir Iſaac Newton's formula I deduce $t=\sqrt{\frac{d\times\Delta}{\delta}\frac{\times 1}{229}\frac{\times 1}{D-d}}\times 23'.56''$

The micrometers ordered for the Obſervatory being not yet arrived, I requeſted a gentleman of known accuracy to take theſe meaſures for me; he was ſo obliging as to ſend me a great number, agreeing remarkably together, from which I find Saturn's diameters, reduced to his mean diſtance, 18″,12 and 15,855.

From hence, taking Sir Iſaac Newton's ratio of the earth's equatorial diameter and axis, and that of the earth and Saturn's denſities, as by him computed, the formula will give for Saturn's ſidereal rotation 10 H. $12'\frac{1}{2}$.

It is a circumſtance worth remarking, that the celebrated Huyghens, in his whimſical and ingenious work, intitled Coſmotheoros, has the following paſſage: "Quam habeant dierum longi-"tudinem (Saturnicolæ ſciz.) certo cognoſci nequit; ſed ex "comitis intimi diſtantiâ ac periodo, exque eorum comparatione "cum intimo Jovialium; veriſimile fit non longiores eſſe dies "illas

" illas quam ſint in Jove ſciz. 10 horarum aut paulo minus." We dwell with pleaſure upon the ſlighteſt conjectures of ſuch an enlightened mind.

By the ſame formula I computed the time of his rotation, taking the denſity of Saturn as deduced by Mr. de la Lande in the fourth volume of his Aſtronomy, by which it came out 12 H. 55′ $\frac{1}{3}$.

I computed it alſo, taking this laſt denſity and Mr. Bouguer's ratio of the earth's diameters (which has many advocates) and on this ſuppoſition it came out 14 H. 44′ $\frac{1}{2}$ nearly.

From the great modern improvement of teleſcopes it may reaſonably be expected that his time of rotation will ſoon be determined by actual obſervation; and from the two ſatellites lately diſcovered by the celebrated Mr. Herſchel, his denſity will ſoon be more accurately aſcertained.

And when the denſity of the Georgian planet ſhall have been determined by means of his ſatellites, diſcovered alſo by Mr. Herſchel, perhaps ſome correct law of the denſities may be had; which, if it be found to obtain accurately in thoſe planets which have ſatellites, may, perhaps reaſonably, be extended to thoſe which have none; and enable us to determine the quantity of matter and denſity of Venus, Mars and Mercury, without having recourſe to the decrement of the obliquity of the ecliptic, a matter ſo delicate in itſelf, that even at this day, there

there are ſome who doubt the fact, though ſupported by ſound theory and obſervation.

THE following method of determining the quantity of matter in Mars, Venus and Mercury, or any other planet, is certainly true in theory.

THE axis major of the earth's orbit as it revolves round the common center of gravity of earth and ſun = 200000. The quantity of matter in the earth we aſſume = 1, that of the ſun is then 352813, the parallax being allowed 8".6. Now by Prop. 60, Book I. of Newton's Principles, as $\sqrt[3]{352814} : \sqrt[3]{352813}$ ſo is the axis major of the ellipſe round the common center of gravity, to the axis major of an ellipſe which would in the ſame periodical time be deſcribed round the ſun at reſt, and is therefore had by the analogy.

VENUS's axis major (Coſſ. El. Aſt.) round the common center of gravity of the ſun and Venus = 144662 by obſervation. Now in the ſubſeſquiplicate ratio of the periodical times of the earth and Venus take the earth's diminiſhed axis major to a fourth quantity, and we have the axis major of the ellipſe which Venus would deſcribe round a fixed ſun; but we had it by obſervation round the common center of gravity.

THEN let ☉ = the ſun's quantity of matter, ♀ = that of Venus, let $m$ = the axis major of her orbit round the common center of gravity, and I = that deduced as above round the fixed ſun.

Then

Then $m : I :: \sqrt[3]{\odot + \varsigma} : \sqrt[3]{\odot}$. And $m^3 : I^3 :: \odot + \varsigma : \odot$. Therefore $m^3 - I^3 : I^3 :: \varsigma : \odot$. And therefore $I^3 : m^3 - I^3 :: \odot : \varsigma$. Q. E. I. from whence the denſity is eaſily deduced. However I freely allow all the difficulties of reducing this to practice.

N. B. If we take the law of the denſities laid down by Mr. de la Lande, viz. as the roots of mean motion, the denſity of Saturn inſtead of ,10448, which is his number, will come out ,18351, much nearer to Newton's, which reduced to this ſcale would be ,16750. But Newton's quantities of matter were neceſſarily defective from applying the ſolar parallax 10″,5 inſtead of 8″,6.